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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/912,558	07/26/2001	Ronald A. Weimer	M4065.0319/P319-A	5990

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EXAMINER

KIELIN, ERIK J

ART UNIT	PAPER NUMBER
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2813

DATE MAILED: 10/07/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/912,558

Applicant(s)

WEIMER ET AL.

Examiner

Erik Kielin

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-- The MAILING DATE of this communication appears on the cover sheet with the corresponding address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 29 August 2002.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 13, 14, 16, 17, 42 and 43 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 13, 14, 16, 17, 42 and 43 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s) _____.
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____. 6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 8 August 2002 has been entered.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 13, 14, 16-17, 41 and 42 are rejected under 35 U.S.C. 103(a) as being unpatentable over the article **Luan**, et al. "Ultra thin high quality Ta₂O₅ gate dielectric prepared by in-situ rapid thermal processing" Electron Devices Meeting, held 6-9 December 1998, IEDM '98 Technical Digest, pp. 609-612 in view of US 6,063,698 (**Tseng** et al.).

Regarding independent claims 13, 41, and 42, **Luan** discloses a method of forming a gate dielectric layer on a substrate comprising the steps of

depositing a dielectric film over an active region of a semiconductor substrate to form part of a gate of a transistor, wherein the dielectric film is tantalum oxide (Ta₂O₅), as further

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limited in claim 17, having the inherent property of a dielectric constant of “at least about 25”

(Introduction), as further limited in instant claim 16; and

subjecting the dielectric film to a wet oxidation using rapid thermal processing (RTP) and therefore occurring, by definition, in a RTP chamber, at a temperature of 600 °C for a period of about 40-50 seconds (Fig. 1) as further limited in instant claim 15, wherein the wet oxidation environment is formed by heating a mixture of H₂ and O₂. (See whole **Luan** article which is very brief.)

Luan does not teach a wet oxidation temperature in the range of 750-950 °C or a ratio of H₂ to O₂ of about 0.1 to 0.8 (i.e. 10% to 80% H₂).

Tseng teaches a process virtually identical to **Luan** of forming a tantalum oxide gate dielectric 14 on a semiconductor substrate 12 and then wet oxidizing by heating a mixture of H₂ and O₂ to a temperatures of 750-850 °C, wherein the H₂ to O₂ ratio is about 0.03 to about 0.09 (col. 6, lines 58-63) to beneficially “eradicate trap sites 16 and 18” (col. 6, lines 39-57). The **Tseng** claim 20 also teaches that the flow rate of O₂ is 20 liters per minute and that of H₂ is 10 liters per minute which is a H₂:O₂ ratio of 0.5 which falls within the instantly claimed range of 0.1 to 0.8. (See also Abstract; col. 5, line 54 to col. 6, line 17.)

It would have been obvious to one of ordinary skill at the time of the invention to modify the method of **Luan** to use the temperature and ratio of hydrogen to oxygen taught by **Tseng** in order to beneficially reduce the trap sites and improve the dielectric as taught by **Tseng** and to further reduce the leakage current as taught by **Luan** which is a direct measure of the reduction of trap sites, as taught by **Tseng** (Abstract; col. 4, first paragraph)--especially since the methods are virtually the same.

Further in this regarding, it would be a matter of routine optimization to determine the optimum ratio of hydrogen to oxygen, since **Luan** clearly teaches the use of hydrogen and oxygen therefore expressly indicating some ratio. The selection of the ratio is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. *In re Jones*, 162 USPQ 224 (CCPA 1955)(the selection of optimum ranges within prior art general conditions is obvious). In the instant case, Applicant has not provided any evidence that the claimed ratio provides unexpected results relative to that used in **Luan**. Furthermore, the temperature would also amount to routine optimization with consideration to **Tseng** because, it has been held that claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. *In re Huang*, 40 USPQ2d 1685, 1688(Fed. Cir. 1996).

Regarding claim 41, if it is thought that **Luan** does not inherently teach an actual thickness of Ta_2O_5 of greater than 40 Å, then this may be a difference. But **Tseng** teaches that a T_{eq} (*equivalent* thickness relative to an actual thickness of SiO_2) of 20 Å is equal to an actual thickness T_{actual} of 60 Å of high dielectric constant material (e.g. tantalum oxide, Ta_2O_5). (See **Tseng**, col. 4, line 35-43). This indicates that the **Luan** T_{actual} is **necessarily** thicker than the T_{eq} reported because tantalum oxide is a high dielectric constant material. **Luan** teaches a T_{eq} of 13-25 Å wherein the 13 Å T_{eq} is the "thinnest ever reported." (See **Luan**, first paragraph under the section entitled, "2. Leakage Current")

Accordingly, it would be obvious for one of ordinary skill in the art, at the time of the invention, to form the tantalum oxide in **Luan** to T_{actual} 60 Å to attain the T_{eq} of about 20 Å reported in **Luan**, as taught also by **Tseng**.

Response to Arguments

4. Applicant's arguments filed 8 August 2002 have been fully considered but they are not persuasive.

Applicant appears to argue that Luan does not teach wet oxidation simply because Luan doesn't use the terminology "wet oxidation". Examiner respectfully but emphatically disagrees. As stated in the previous action under the section entitled "*Response to Arguments*" in the previous action (Paper No. 12, filed 8 May 2002), both Applicant and Luan heat mixtures of H_2 and O_2 to form water (H_2O) in its vapor state --i.e. steam. If Luan is not forming steam then Applicant has a *major enablement problem* since both are heating mixtures of H_2 and O_2 , to temperatures greater than 450 °C, which necessarily produces steam. Applicant is requested to provide evidence that Luan is somehow **not** forming steam, but Applicant, with the same mixture and the same temperature is somehow forming steam. (See Van Zant, Microchip Fabrication, 4th ed. McGraw-Hill: New York, 2000, pp. 172-173.) Accordingly, the arguments regarding the Luan article are wholly without merit. *Applicant has continued to fail to provide evidence.*

Moreover, reduction of high dielectric constant materials necessarily damages them by removing oxygen, contrary to the purpose for the wet oxidation. Accordingly, Applicant's argument is without merit.

Applicant's arguments regarding the hydrogen concentration are selective and fail to consider the entire reference. Accordingly this argument, too is without merit as Tseng clearly teaches a ratio falling near the middle of the instantly claimed range.

Applicant argues that Tseng would not be combined with Luan properly. Examiner respectfully disagrees. In response to applicant's argument that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case, the suggestion to combine is as stated above in the body of the rejection, or to re-state, in order to beneficially reduce the trap sites as taught by **Tseng**.

Applicant further argues in this regard that Luan provides a NO passivation layer to prevent consumption of the silicon substrate, and for this reason, would not be properly combined with Tseng, since Tseng aims to consume plasma-damaged silicon. Examiner acknowledges Applicant's point but respectfully disagrees that this undermines the combination of the references. Tseng also indicates that dangling bonds are reduced at the interface of the dielectric and the silicon substrate, which reduces leakage current (Abstract; col. 4, first paragraph). Luan also teaches that leakage current is reduced thereby indicating the loss of dangling bonds. For this reason the details of the wet oxidation in Tseng would not be ignored since Luan has merely not provided specific details of the H₂:O₂ ratio and uses a slightly lower temperature than in Tseng. Moreover, Applicant has not provided evidence of unexpected results

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for the $H_2:O_2$ ratio and temperature used as required by the precedent of *In re Huang*, as noted above. One of ordinary skill would be motivated to provide optimum conditions and a higher temperature would speed up the processing.

Applicant then argues that because Luan uses an Al gate, that the temperature must be below 520 °C. This argument is not persuasive because Luan specifically states using 600 °C to carry out an exemplary anneal. Applicant appears to be ignoring the express teachings in Luan.

Conclusion

5. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

US 5,907,780 (**Gilmer** et al.) discloses a method of forming a high dielectric constant gate dielectric by depositing a high dielectric constant material (col. 7, lines 22-49) insulating material, implanting silicon, and then wet oxidizing at 750 °C to fill oxygen vacancies (paragraph bridging cols. 7-8).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980. The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached at 703-308-4940. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

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Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Erik Kielin

October 3, 2002